APPENDIX 1. THREAT MODELING METHODOLOGY

Geographic Extent and Resolution. The Reefs at Risk in Southeast Asia (RRSEA) project includes an area in Southeast Asia approximately bounded by 90°E and 142°E longitude, and 30°N and 11°S latitude. The data integration and analysis were performed in an equal-area projection (Lambert Equal Area Azimuthal 126, 6) at a 1,000 meter (1 kilometer) resolution.

Data Development and Modeling Process. Modeling of threats to coral reefs in Southeast Asia was implemented at WRI, using an iterative approach with extensive input from project partners. *(See front cover for list of project partners.)* Input data sets, the model design, and model results have been extensively reviewed and significantly revised based on input from project partners and at two regional workshops (the RRSEA workshop, April 2000 in Quezon City, Philippines, and the International Coral Reef Symposium, October 2000 in Bali, Indonesia).

Model Overview. The modeling approach groups threats into five main categories: coastal development, marine-based pollution, overfishing, destructive fishing, and sedimentation from inland sources. Mappable component sources of potential degradation were identified for each threat category. The following provides a brief summary, but the full description of the model methodology is available from the RRSEA web site, www.wri.org/wri/reefsatrisk.

- The threat associated with coastal development was evaluated based upon a coral reef's distance from cities (stratified by size), settlements (stratified by population density and growth), airports, mines, tourist resorts, dive centers, and the coastline.
- The threat associated with marine pollution was evaluated in a similar way, based upon a reef's distance from ports (stratified by size), major shipping lanes, and oil tanks and wells.
- A watersed-based analysis was used to estimate sediment risk to coral reefs. Using a modified form of the Revised Universal Soil Loss Equation (RUSLE)[169], the analysis first calculated relative erosion rates for all land areas by 1-km grid cell based upon slope, land cover type, precipitation, and soil porosity. These relative erosion rates were summarized by watershed and then combined with an estimate of precipitation in the watershed during the peak rainfall month to estimate sediment delivery at river mouths during high flow periods. Sediment plumes (dispersion) were modeled using a distance-degrade function, and were calibrated against observed sediment plumes and observations of sediment impact to coral reefs.
- Overfishing pressure on coral reefs up to 20 km offshore was estimated based upon total population within 10 km of the coast. Excluded were coastal populations in highland areas (above 800 m) and those areas with high per capita GDP (over US$20,000 in 1997) where per capita fish consumption is less than 50 kg per year.
- The threat from destructive fishing was evaluated using an expert mapping approach instead of modeling. RRSEA worked with collaborators throughout the region to map areas where fishing with poisons and blast fishing are occurring or have occurred recently.

For three threat categories — coastal development, marine-based pollution, and pollution and sedimentation from inland sources — the "raw" threat estimates were adjusted based upon an indicator of the natural vulnerability of the area to pollution and sedimentation. In addition, three "raw" threat estimates — overfishing, destructive fishing, and coastal development — were adjusted to account for the management effectiveness of the area. The five adjusted threat estimates were then combined into an integrated estimate of threat from human activity. A 1-km resolution grid reflecting coral reef locations was overlaid with the integrated threat estimate to produce the Reefs at Risk Threat Index — coral reefs rated by estimated threat from human activities.

For full technical notes on the modeling method, including data sources, or to download model results, see www.wri.org/wri/reefsatrisk.